Vol 14 Vol 14

Alaska Department of Fish and Game

James W Brooks, Commissioner

FEDERAL AID IN FISH RESTORATION • • • VOLUME 14

SPORT FISH DIVISION

STUDY R-I

DISTRIBUTION, ABUNDANCE, AND NATURAL HISTORY OF THE ARCTIC GRAYLING IN THE TANANA RIVER DRAINAGE.

-BY-

STEPHEN L. TACK

F-9-5

PERIOD COVERED

JULY 1, 1972
through
JUNE 30 1973

Subport Building
Juneau, AK. 99801

STATE OF ALASKA

William A. Egan, Governor

Annual Progress Report for

DISTRIBUTION, ABUNDANCE, AND NATURAL HISTORY OF THE ARCTIC GRAYLING IN THE TANANA RIVER DRAINAGE

by

Stephen L. Tack

ALASKA DEPARTMENT OF FISH AND GAME

James W. Brooks, Commissioner

DIVISION OF SPORT FISH

Rupert E. Andrews, Director
Howard E. Metsker, Coordinator

TABLE OF CONTENTS

RESEARCH PROJECT SEGMENT

State: Alaska

Project No.: F-9-5 Name: Sport Fish Investigations of Alaska.

Study No.: R-I Study Title: Distribution, Abundance, and Natural History of the Arctic Grayling in the Tanana River Drainage.

Period Covered: July 1, 1972 to June 30, 1973.

ABSTRACT

Arctic grayling, Thymallus arcticus, population estimates in the lower Chena River were done for the fifth year and population estimates were calculated for the first time on the Chatanika, Salcha, and Goodpaster rivers.

Capture rates by species and length frequencies for grayling are presented for all areas sampled during 1972.

Spring netting on the upper Chena River revealed an upstream migration starting about April 20, 18 days prior to breakup. The run consisted of immature grayling until May 6 when spawners began moving into the upper river. Spawning began about May 26 and was followed by a second movement of spawned-out grayling into the small tributaries of the upper Chena River.

The length-weight relationship, dorsal fin and pelvic fin development, coefficient of condition, and lateral line scale count is presented for the grayling sampled during the spring study on the upper Chena River.

Growth curves for grayling from six Interior and Arctic waters are presented.

The results of a preliminary study of grayling swimming ability is presented.

Post spawning movement of grayling from the Mineral Lake outlet spawning grounds is described. The substrate composition of the Mineral Lake outlet spawning ground is also presented.

A total of 7,174 angler hours was estimated for the spring fishery on Badger Slough. The lower 34.6 km (21.5 miles) of the Chena River received an estimated 13,116 angler hours of effort between May 25 and September 27.

RECOMMENDATIONS

It is recommended that:

1. The timing and composition of the spring upstream migration of grayling in the Goodpaster River be determined.
2. Grayling population estimates, length frequencies, and catch composition be conducted in designated sections of the Goodpaster river.
3. Spawning areas, distribution, and conditions be studied in the Goodpaster River.
4. A creel census be conducted on the Goodpaster River.
5. Effort to determine the winter distribution of grayling be continued.

TECHNIQUES

Grayling for population and length composition studies were captured by an alternating current shocker boat. This unit was described by Van Hulle (1968), and Roguski and Winslow (1969). Species composition was also determined from shocker boat samples. A standard procedure of alternating shocking effort between river banks every 15 minutes was established. Data were taken and fish released after each 15 minute period. Fish captured during the period were returned to the upper end of the segment and released.

Estimation of grayling populations was accomplished by the Schnabel tag and recapture method.

Monofilament gillnets, 125' X 6', with five graduated mesh sizes, 0.5 - 2.5 inches bar measure, were used to sample stocked lakes and ponds.

Monofilament gillnets, 25' and 50' long by 6' deep and of constant mesh sizes of 1 to 2.5 inches bar measure, were used to capture grayling during the spring study on the upper Chena River and at Mineral Lake Outlet.

Angler use estimates for Badger Slough and the Lower Chena River were made by a stratified system of randomized angler counts. Counts were made from a motor vehicle on Badger Slough and from a boat on the lower Chena River. Interviews with completed anglers were used to compute catch statistics.

A Hach Model AL-36-WR water test kit was used to measure dissolved oxygen.

A Bausch and Lomb microprojector was used for determining age of grayling by scales. Scales were cleaned and mounted between glass slides. All scales were measured to facilitate back calculation of age. Age data were entered on IBM coding forms for future computer analysis.

An IBM 360 computer was used to analyze autopsy data.

Bottom samples taken from the Mineral Lake Outlet spawning grounds were analyzed using U.S.A. standard testing sieves with openings of 0.075 mm (0.0029 in.), 2.36 mm (0.0937 in.), 6.35 mm (0.25 in.), 12.7 mm (0.5 in.), 25.4 mm (1.0 in.), and 38.1 mm (1.5 in.).

FINDINGS

Job R-I-A Population Structure, Summer Distribution, and Interspecific Competition in the Chena River and Other Tributaries of the Tanana River.

Objectives:

1. To determine the age composition of grayling in selected sections of the Chena River and compare growth rates of fish from these sections to determine whether separate populations exist within the river.
2. To determine the extent and timing of intrastream movements.
3. To determine relative abundance of grayling and other species in selected sections of the Chena and Delta Clearwater rivers, and if time permits, in the Goodpaster, Salcha, Chatanika, Richardson Clearwater, and Delta rivers of the Tanana drainage and important rivers of the upper Yukon drainage.

Population Estimates

Arctic grayling, Thymallus arcticus, population estimates were conducted in sections 2a, 2b, 6 (Table 1) and in the area of the proposed dam site, Mile 44 to 47, of the Chena River (Table 2). Cumulative grayling population estimates since 1968 are shown in Table 3. Population levels in sections 2a, 2b and 6 declined from their 1971 levels and, in section 6, dropped to the lowest level since 1968 when estimates were first made. No reason for this general decline is apparent but a cyclic population fluctuation is suspected and will be investigated.

Grayling population estimates were made in index sections in the Chatanika, Salcha, and Goodpaster rivers (Table 4). The Chatanika section ran from 3.2 km (2 mi.) above the Elliot Highway bridge to 1.6 km (1 mi.) below the bridge. The Salcha section was the 4.8 km (3 mi.) below the Redmond Creek confluence, and the Goodpaster section was the 4.8 km (3 mi.) above Jolly's Cabins. The water in each stream was very clear and soft when sampled making sampling very difficult. In the Salcha and Goodpaster rivers, shocking done after sundown was productive. The estimates obtained because of the small number of fish marked and recaptured must be regarded with caution.

Length Frequency

The length frequencies obtained while conducting population estimates in the Chena, Chatanika, Salcha, and Goodpaster rivers and during the spring creel census on Badger Slough (Table 5) show the characteristic

TABLE 1 Chena River Study Sections used during the 1972 Arctic Grayling Studies.

Section Number	Section Name	River Miles*	Section Length Miles*
1	Mouth to University Ave.	0 - 6 (0 - 9.7)	6 (9.7)
2a	University Ave. to Peger Rd.	6 - 8 (9.7-12.9)	2 (3.2)
2b	Peger Rd. to Wendel St.	8 - 11 (12.9-17.7)	3 (4.8)
3	Wendel St. to Wainwright RR Bridge	11 - 14.5 (17.7-23.3)	3.5 (5.6)
4	Wainwright RR Bridge to Badger Slough	14.5 - 21.5 (23.3-34.6)	7 (11.3)
5	Badger Slough		16.5 (26.6)
6	Badger Slough to Little Chena River	21.5 - 25 (34.6-40.3)	3.5 (5.6)
7	Little Chena River		61.5 (99.0)
8	Little Chena River to Nordale Slough	25 - 31.5 (40.3-50.7)	6.5 (10.5)
9a	Nordale Slough to Bluffs	31.5 - 55.5 (50.7-89.4)	24 (38.6)
9b	Bluffs to Bailey Bridge	55.5 - 63 (89.4-101.4)	7.5 (12.1)
10	Bailey Bridge to Hodgins Slough	63 - 79 (101.4-127.2)	16 (25.8)
11	Hodgins Slough to 90 Mi. Slough	79 - 90 (127.2-144.9)	11 (17.7)
12	90 Mi. Slough to 1st bridge	90 - 92 (144.9-148.1)	2 (3.2)
13	First bridge to 2nd bridge	92 - 94.5 (148.1-152.1)	2.5 (4.0)

TABLE 1 (Cont.) Chena River Study Sections

Section Number	Section Name	River Miles*	Section Length Miles*
14	Second bridge to North Fork of Chena River.	94.5 - 102 (152.1-164.2)	7.5 (12.1)
15	North Fork of Chena River		35 (56.4)
16	East Fork of Chena River		62 (99.8)

*Kilometers in parentheses

TABLE 2 Grayling Population Estimates in Four Chena River Sections, 1972.

River Section	Date	Length of Section km (mi)	Number Marked	Schnabel Estimates Gr/km (Gr/mi)	95% Confidence Limits (Gr/km)
2a	6/22-26/72	3.2 (2)	244	416 (666)	318 - 658
2b	6/22-26/72	4.8 (3)	648	919 (1,471)	746 - 1,251
6	6/19-20/72	4.8 (3)	259	207 (331)	162 - 306
Dam site	6/27-29/72	4.8 (3)	520	1,140 (1,824)	848 - 1,956

TABLE 3 Grayling Population Estimates for Chena River, Sections 2a, 2b and 6, 1968-1972.

River Section	Year	Dates	Gr/km	(Gr/mi)
2a	1971	8/30-9/3	684	(1,095)
	1972	6/22-6/26	416	(666)
2b	1968	———	684	(1,095)
	1969	———	1,181	(1,890)
	1970	7/2-7/10	1,540	(2,465)
	1971a	6/2-6/7	2,036	(3,257)
	1971b	8/30-9/3	2,338	(3,741)
	1972	6/22-6/26	919	(1,471)
6	1968	———	282	(452)
	1969	———	571	(913)
	1970	5/26-5/30	481	(769)
	1971	6/21-6/24	368	(589)
	1972	6/19-6/20	207	(331)

TABLE 4 Grayling Population Estimates for the Chatanika, Salcha and Goodpaster Rivers,1972.

River	Inclusive Dates of Sampling	Number		Schnabel Estimate	
		Marked	Recaptured	Gr/km	(Gr/mi)
Chatanika, Vicinity of Elliot Hwy Bridge	8/10-8/17	103	4	305	(488)
Salcha, Vicinity of Redmond Creek	8/2-8/4	163	5	503	(805)
Goodpaster, Vicinity of Jolly's Cabins	7/12-7/14	210	30	189	(303)

predominance of rearing fish (less than 270 mm fork length) in the lower reaches of these rivers. The angler-caught sample from Badger Slough was taken during the grayling spawning migration which accounts for the absence of the smaller length groups in this sample.

Only Sec. 1 and Sec. 6 of the Chena River lack strong percentages of grayling between 140 and 170 mm fork length. These two sections also have low numbers of fish per mile.

Capture Rates

The capture rates for grayling and associated fish species were recorded along with population estimates to assess their use as indices of abundance (Table 6). They also provide a means of expressing the relative abundance of the fish species captured while electrofishing. As stated in Tack's 1972 annual progress report, capture rates would be regarded as potentially comparable only within the same river section from year to year, not from one river section to another. Furthermore, the capturing should be done at approximately the same time and under the same weather and water conditions from year to year. Too little data are presently available to assess the general usefulness of capture rate as an indicator of abundance.

Spring Migration in the Chena River

Gillnet stations maintained before, to some extent during, and following spring breakup considerably increased knowledge of the spring migration in the Chena River. The results of this netting are summarized in Table 7. The first evidence of movement occurred April 20 when the first grayling was caught at 101 km (63 mi.). Prior to this catch all grayling captured had been near a heated outfall at 24 km (15 mi.) and all of these were immature. This initial catch occurred after two weeks of continual netting at the 101 km site. By April 20 considerable melt had taken place at the 101 km site but most of the river remained ice covered and the water temperature had not risen above 0°C. Grayling captured at 101 km (April 20 - May 2) were all immature averaging 201 mm fork length (range 154-240 mm).

On May 5, seven immature and seven mature grayling were taken at 24 km; on May 6, four immature and seven mature grayling were taken at 101 km, indicating onset of the spawning run. On May 6 and 7, water flow began increasing and on May 8 breakup occurred and water flow increased sharply, washing away all nets. The large catches of gravid grayling at 24 and 101 km at about the same time indicated that adult grayling were present downstream of 24 km and between the two sites but not above 101 km as shown by lack of captures at 148 km (92 mi.). The capture of adult grayling at 48 km (30 mi.) during the winter of 1970-71 (Tack, 1971) further shows that overwintering occurs in the Chena River downstream of 101 km.

TABLE 5 Length Frequency by Percent of Nine Electrofishing Samples and One Angler Sample from Various Sites in the Tanana River Drainage, 1972.

Fork Length in mm	Chena R. Sec. 1 7/26	Chena R. Sec. 2a 6/22-6/23	Chena R. Sec. 2b 6/22-6/23	Chena R. Sec. 6 6/19	Chena R. at Dam Site 6/27-6/29	Badger Slough Angler Catch April & May	Salcha R. below Redmond Creek 8/2-8/4	Lower 16 km(10 mi) of Goodpaster R. 7/12-7/14	8/23	Chatanika R. Vicinity of Elliot Hwy Bridge 8/10-8/17
0- 10										
11- 20										
21- 30										1.4
31- 40										
41- 50										
51- 60									.5	
61- 70		.4		.3			1.3		.5	
71- 80			.1				3.9		.5	
81- 90		.8	.6				7.9	.7	1.1	.7
91-100		.4	.1	.6	.2		2.6	.4		.7
101-110		1.1	.6	.3	3.1		1.8			.7
111-120	1.1	1.5	.9	5.5	9.9		1.8	.4	1.1	5.4
121-130	5.3	1.5	4.5	5.5	7.5		2.2	4.1	4.4	4.1
131-140	1.1	8.0	11.2	6.1	1.9		7.5	16.4	7.1	.7

TABLE 3 (Cont.) Length Frequency by Percent of Sample of Nine Electrofishing and One Angler Sample from Various Sites in the Tanana River Drainage, 1972.

Fork Length in mm	Chena R. Sec. 1 7/26	Chena R. Sec. 2a 6/22-6/23	Chena R. Sec. 2b 6/22-6/23	Chena R. Sec. 6 6/19	Chena R. at Dam Site 6/27-6/29	Badger Slough Angler Catch April & May	Salcha R. below Redmond Creek 8/2-8/4	Lower 16 km(10 mi) of Goodpaster R. 7/12-7/14	8/23	Chatanika R. Vicinity of Elliot Hwy Bridge 8/10-8/17
141-150	2.1	11.8	15.5	4.6	5.8		7.5	13.8	17.6	4.1
151-160	1.1	15.2	12.2	4.9	13.6	4.8	4.8	7.1	17.6	18.4
161-170	7.4	12.5	7.5	6.3	12.2	1.9	4.4	4.1	15.4	15.0
171-180	7.4	6.5	8.5	7.8	6.5	8.6	3.9	6.7	3.8	12.9
181-190	21.1	3.8	7.7	6.6	3.2	3.8	4.4	6.0	4.4	4.1
191-200	17.9	5.3	9.1	8.4	3.4	1.9	2.6	5.6	5.5	5.4
201-210	8.4	6.8	6.6	13.5	4.5	6.7	4.4	10.8	2.7	8.2
211-220	3.2	4.9	6.3	10.4	5.7	8.6	3.9	4.8	6.0	8.2
221-230	2.1	5.3	3.3	6.3	5.5	11.4	7.0	3.7	2.7	2.7
231-240	1.1	3.4	1.6	5.2	4.5	13.3	4.4	3.4	2.7	1.4
241-250	6.3	3.8	1.2	3.2	1.9	8.6	4.4	1.9	2.2	4.1
251-260	1.1	1.9	1.0	3.2	4.4	11.4	5.7	4.8	1.6	1.4
261-270	4.2	3.4	.4	.6	2.6	2.9	7.0	1.9	1.1	.7
271-280		.4	.1	.3	1.1	7.6	3.5	1.5	1.1	

TABLE 5 (Cont.) Length Frequency by Percent of Sample of Nine Electrofishing and One Angler Sample from Various Sites in the Tanana River Drainage, 1972.

Fork Length in mm	Chena R. Sec. 1 7/26	Chena R. Sec. 2a 6/22-6/23	Chena R. Sec. 2b 6/22-6/23	Chena R. Sec. 6 6/19	Chena R. at Dam Site 6/27-6/29	Badger Slough Angler Catch April & May	Salcha R. below Redmond Creek 8/2-8/4	Lower 16 km(10 mi) of Goodpaster R. 7/12-7/14	8/23	Chatanika R. Vicinity of Elliot Hwy Bridge 8/10-8/17
281-290	2.1	.4	.4	.3	.8	3.8	.9			
291-300	1.1	.4	.4	.3	.8	2.9	1.8	1.9		
301-310	1.1	.4			.5	1.9				
311-320	1.1									
321-330	1.1									
331-340	1.1				.2					
341-350	1.1									
351-360							.4			
361-370					.2					
371-380	1.1									
Total No. in sample	95	263	671	347	617	105	228	268	182	147

TABLE 6 Capture Rate of Grayling and Associated Fish Species in the Chena, Goodpaster and Chatanika Rivers Using Electrofishing, 1972.

River	Fish Per Hour						Hours Shocked
	GR	RWF	S	NP	BB	Other Whitefish	
Chena							
Sec. 2a	126.6	12.5	30.2	.5	.5	5.2	1.92
Sec. 2b	298.2	37.3	70.0	.9	3.6	3.6	2.25
Sec. 6	78.3	21.3	14.2	.9	0.0	.7	4.42
Dam Site	94.2	15.3	7.3	.3	0.0	0.0	6.55
Goodpaster	57.2	34.1	11.6	.3	3.0	.2	6.62
Chatanika	33.1	27.7	.3	0.0	0.0	Not sampled (very numerous)	3.5

*GR - Grayling
RWF - Round whitefish, Prosopium cylindraceum
S - Longnose sucker, Catostomus catostomus
NP - Northern pike, Esox lucius
BB - Burbot, Lota lota

TABLE 7 Arctic Grayling Captured by Gillnetting at Six Sites on the Chena River, Spring, 1972.

Date	Fort Wainwright 24 km (15 mi) Imm	Gr	SO	Temp*	Bailey Bridge 101 km (63 mi) Imm	Gr	SO	Temp	Colorado Creek 136 km (85 mi) Imm	Gr	SO	Temp	First Bridge 148 km (92 mi) Imm	Gr	SO	Temp	Angel Creek 178 km(110.5 mi) Imm	Gr	SO	Temp	North Fork 188 km(117 mi) Imm	Gr	SO	Temp
4-6					0	0	0																	
4-7	0	0	0																					
4-8	2																							
4-10	0	0	0	9	0	0	0	0																
4-11	0	0	0																					
4-12	0	0	0	11	0	0	0																	
4-13	3	0	0	11																				
4-14				14	0	0	0	0																
4-18					0	0	0																	
4-19	0	0	0																					
4-20					1	0	0	0																
4-24	0	0	0		7	0	0	1																
4-25					0	0	0	0																
4-26					1	0	0																	
4-27					0	0	0																	
4-28					7	0	0																	

TABLE 7 (Cont.) Arctic Grayling Captured by Gillnetting at Six Sites on the Chena River, Spring, 1972.

Date	Fort Wainwright 24 km (15 mi)				Bailey Bridge 101 km (63 mi)				Colorado Creek 136 km (85 mi)				First Bridge 148 km (92 mi)				Angel Creek 178 km(110.5 mi)				North Fork 188 km(117 mi)			
	Imm	Gr	SO	Temp*	Imm	Gr	SO	Temp	Imm	Gr	SO	Temp	Imm	Gr	SO	Temp	Imm	Gr	SO	Temp	Imm	Gr	SO	Temp
5-1					6	0	0																	
5-2					2	0	0																	
5-4													0	0	0									
5-5	7	7	0										0	0	0									
5-6					4	7	0																	
5-17																					1	0	0	2
5-18														10		2.0				2.5	1	1	0	1.5
5-20									0	1	0	0					0	0	0	2.0				
5-22												3.5								2.0				
5-23									2	1	0	3.5					0	1	0	3				3
5-24												3					0	0	0	3	0	2	0	3.5
5-26												4					0	0	1	5	0	0	0	
5-28												6								4				5
5-31												7								4				

TABLE 7 (Cont.) Arctic Grayling Captured by Gillnetting at Six Sites on the Chena River, Spring, 1972.

Date	Fort Wainwright 24 km (15 mi) Imm	Gr	SO	Temp*	Bailey Bridge 101 km (63 mi) Imm	Gr	SO	Temp	Colorado Creek 136 km (85 mi) Imm	Gr	SO	Temp	First Bridge 148 km (92 mi) Imm	Gr	SO	Temp	Angel Creek 178 km(110.5 mi) Imm	Gr	SO	Temp	North Fork 188 km(117 mi) Imm	Gr	SO	Temp
6-1												5.5								5.5				4
6-2									12	7	6	5												
6-3																	0	0	0	3.5	1	3	18	3.5
6-4																	2	4	2		0	5	3	3
6-5																	0	1	4		0	1	2	3
6-6																	0	0	3	4	1	2	3	3.5
6-7																	0	4	6	2				
6-8 thru 6-11	Road washed out																							
6-13																	1	2	10	7	3	0	8	7

*Imm = Immature
Gr = Gravid
SO = Spawned out
Temp = Temperature in degrees Celsius

When netting resumed on May 17 the water was still high and turbid. Both immature and gravid adult grayling were present at 188 km (117 mi.), the station farthest from the Chena River mouth. The water temperature was 2°C at this time. During the ensuing two weeks netting was hampered by high water, but small catches were made indicating that gravid adults as well as immature grayling were entering Colorado Creek and Angel Creek, small tributaries to the Chena River at 137 km (85 mi.) and to the North Fork at 178 km (110.5 mi.), respectively.

The water temperature reached 4°C on about May 26 in Colorado Creek, Angel Creek, and the North Fork of the Chena River and had probably done so earlier in the main Chena River. This is the temperature that triggers spawning (Tack, 1972).

A six-day period of warm weather and water followed (from May 27 through June 2) during which time much, if not all, spawning would be expected to have occurred (Tack, 1972). One spawned out grayling was captured in Angel Creek on May 26.

During the first week of June, water temperatures cooled to about 3°C. Netting during this week (Table 7) produced good catches of both spawned out and gravid grayling. This was unexpected following the period of warm water so the data were re-examined (Table 8). These results show that only four of the 28 grayling, judged at field autopsy to be gravid, were females (taken June 2 -3). No gravid females were taken after June 3. The maturity results based on females are more reliable, because males retain milt for some time after active spawning and can easily be judged gravid or ripe, rather than spawned out.

If nearly all fish captured after June may be regarded as spawned out, a picture of a strong post-spawning movement into the headwater tributaries emerges. These fish apparently spawned in the main Chena River or some other tributary and subsequently moved into the tributaries under study to feed.

Meristics and Morphometrics

The length-weight relationship, dorsal and pelvic fin development, coefficent of condition, and lateral line scale count were determined on a sample of 198 grayling. The fish were captured in the North Fork of the Chena River, at 101 km on the main Chena River, and in Colorado Creek which enters the main Chena River at 137 km (85 mi.). Sampling was done during April, May and early June, 1972. The sample includes grayling of both sexes in both pre- and post-spawning condition.

The length-weight relationship shows a typical curve which is nonlinear at lengths less than 160 mm and more than 320 mm but very nearly linear between these values (Figure 1). There does not appear to be differences between the sexes over the length range considered.

TABLE 8 Spawning Condition of Adult Grayling Captured in Three Headwater Tributaries of the Chena River, 1972.

Date	Colorado Creek				Angel Creek				North Fork			
	Males		Females		Males		Females		Males		Females	
	G*	SO**	G	SO	G	SO	G	SO	G	SO	G	SO
6/2	6	4	2	1								
6/3									1	7	2	11
6/4					4	0	0	2	5	2	0	1
6/5					1	2	0	2	1	0	0	2
6/6					0	3	0	1	2	0	0	3
6/7					4	2	0	4				
Totals	6	4	2	1	9	7	0	9	9	9	2	17

* G = Gravid or ripe
**SO = Spawned out

Other than for swimming, the dorsal fin is erected in display by both sexes of grayling during aggressive encounters and by the male during courtship. Furthermore, the male folds the dorsal fin over the female's back while mating. The pelvic fins are also erected by both sexes during aggressive displays and by the male during courtship. The dorsal and pelvics are colorfully marked in both sexes.

The development of these fins was investigated to find differences between the sexes, if any, that might be useful as an external sex characteristic. The dorsal fin elongates slightly faster in males than in females for fish up through 320 mm fork length (Figure 2). Though insufficient data are presented for fish over 320 mm for comparison, it appears that males may exhibit accelerated dorsal fin elongation after reaching about 350 mm in length. The calculated linear regressions are:

Female dorsal fin length = 44.06 + 0.56 fork length; r = .97
Male dorsal fin length = 55.30 + 0.65 fork length; r = .93

Pelvic fin development is also slightly faster in males than females (Figure 3) over the range of lengths studied. Again it appears that males show rapid pelvic elongation after reaching about 350 mm. The calculated linear regressions are:

Female pelvic fin length = -2.85 + 0.15 fork length; r = .95
Male pelvic fin length = -10.82 + 0.20 fork length; r = .92

For grayling through 320 mm, neither the dorsal nor pelvic fins are sufficiently different between the sexes to serve as an external sex characteristic.

The coefficient of condition (K = weight in grams X 10^5/ (fork length in mm^3) was found to be constant over a wide size range and for both sexes (Table 9). The mean lateral line scale count from hypural plate to head was 92.5 (range 79 - 101; n= 197).

Age and Growth

All grayling scales read for age determination in 1971 and 1972 were measured and recorded on IBM data forms. Back calculation of lengths at each annulus will be done by computer, after an adequate formula relating scale radius to fork length is derived. The growth rates of grayling can then be compared in different waters and under various environmental conditions.

Figure 4 shows growth curves from various waters in Interior and Arctic Alaska, based on observed lengths only. This is a very preliminary analysis and should not be used for comparative purposes, as samples were taken at widely varying times of year.

Grayling Swimming Ability

The ability of fish to pass velocity impediments such as culverts prompted an initial study of the grayling's swimming ability. The results presented are of the most preliminary nature and only intended to establish the basis for a more comprehensive study using more revelant test apparatus.

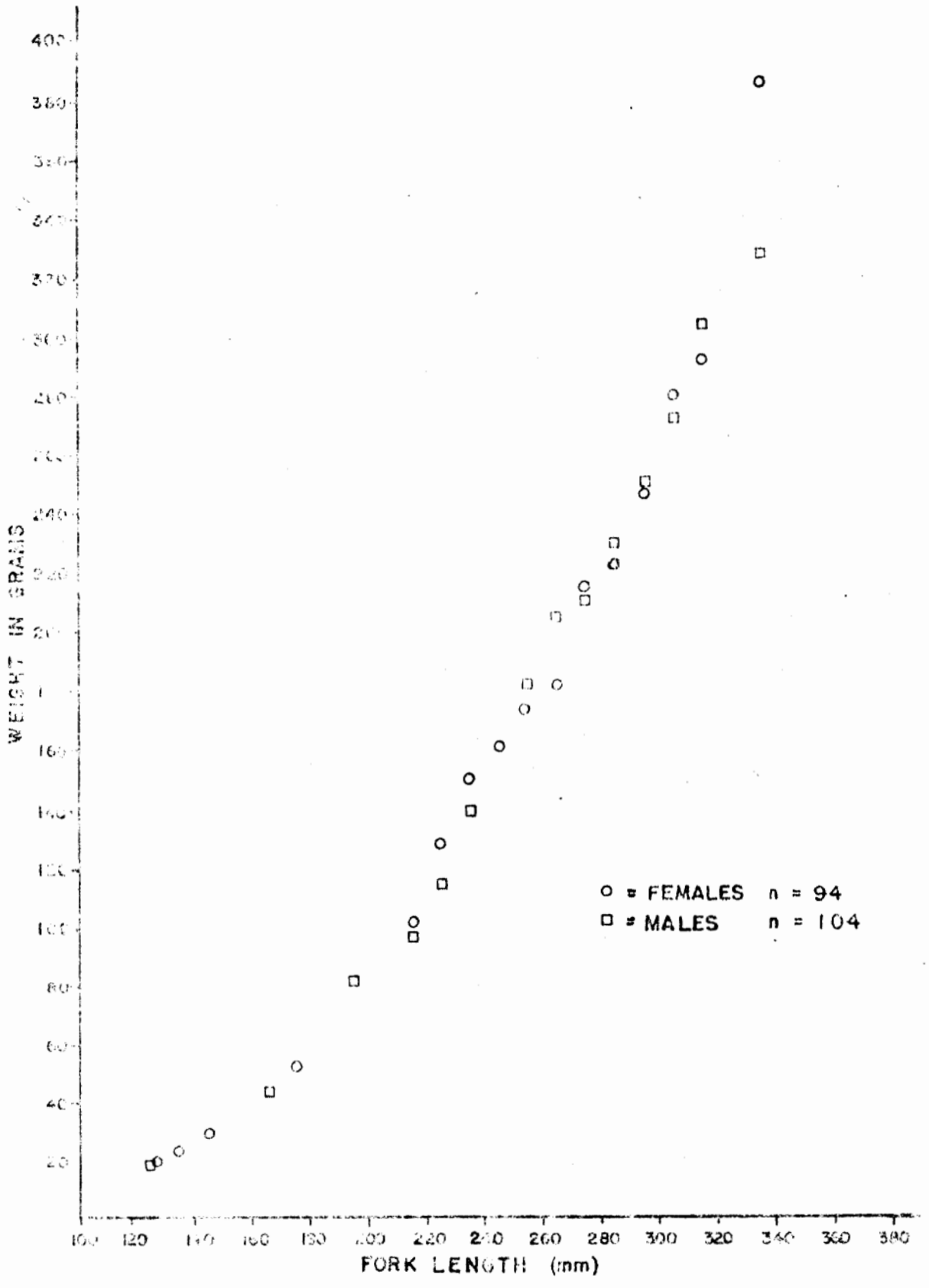

FIGURE 1 Weight to Length Relationship of Grayling Captured during April, May and June, 1972 in the Upper Chena River. Each Point Represents the Mean Weight of all Grayling in each 10 mm Length Group.

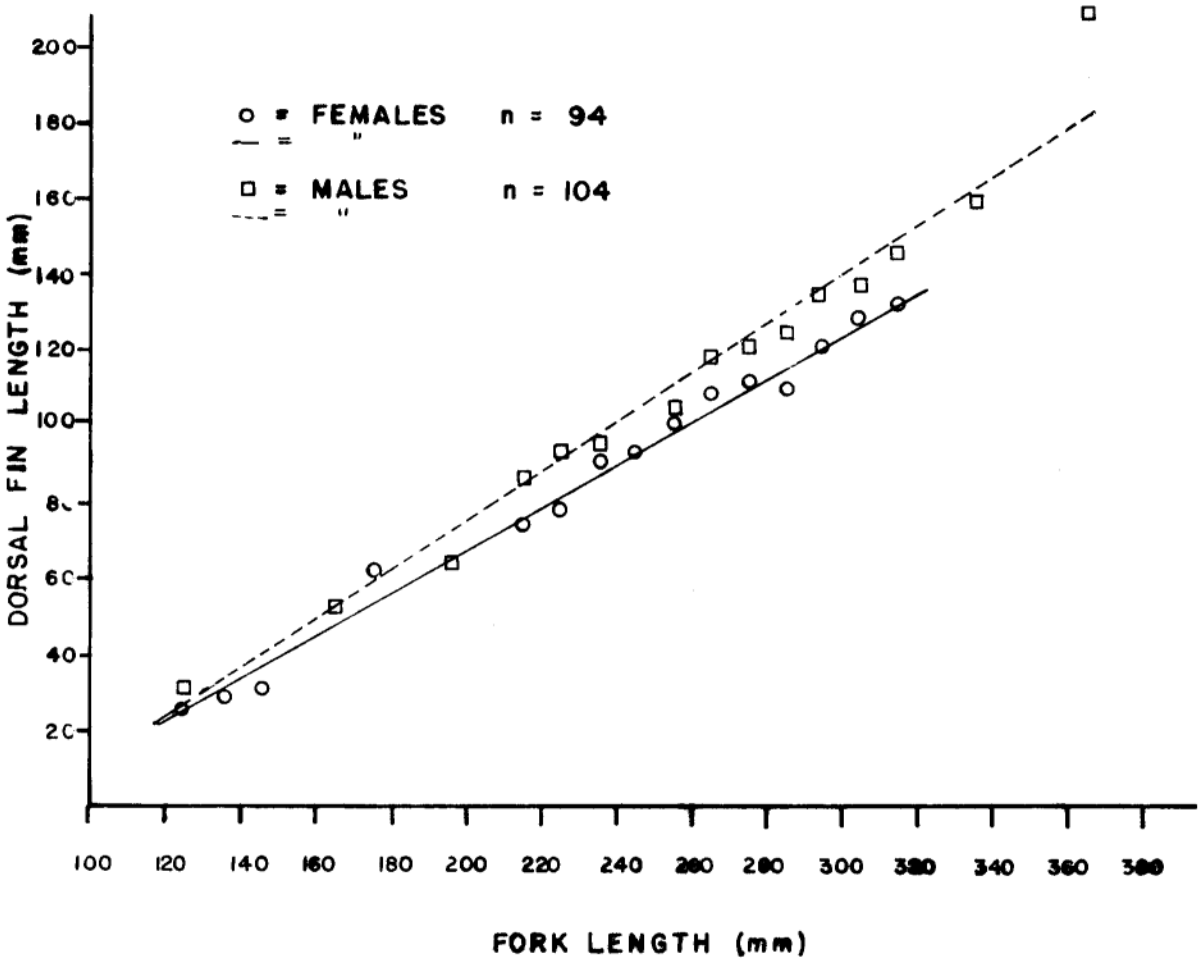

FIGURE 2 Linear Regression of Dorsal Fin Length on Fork Length for Grayling from the Upper Chena River, 1972. Each Point Represents the Mean Dorsal Fin Length for each 10 mm Length Group.

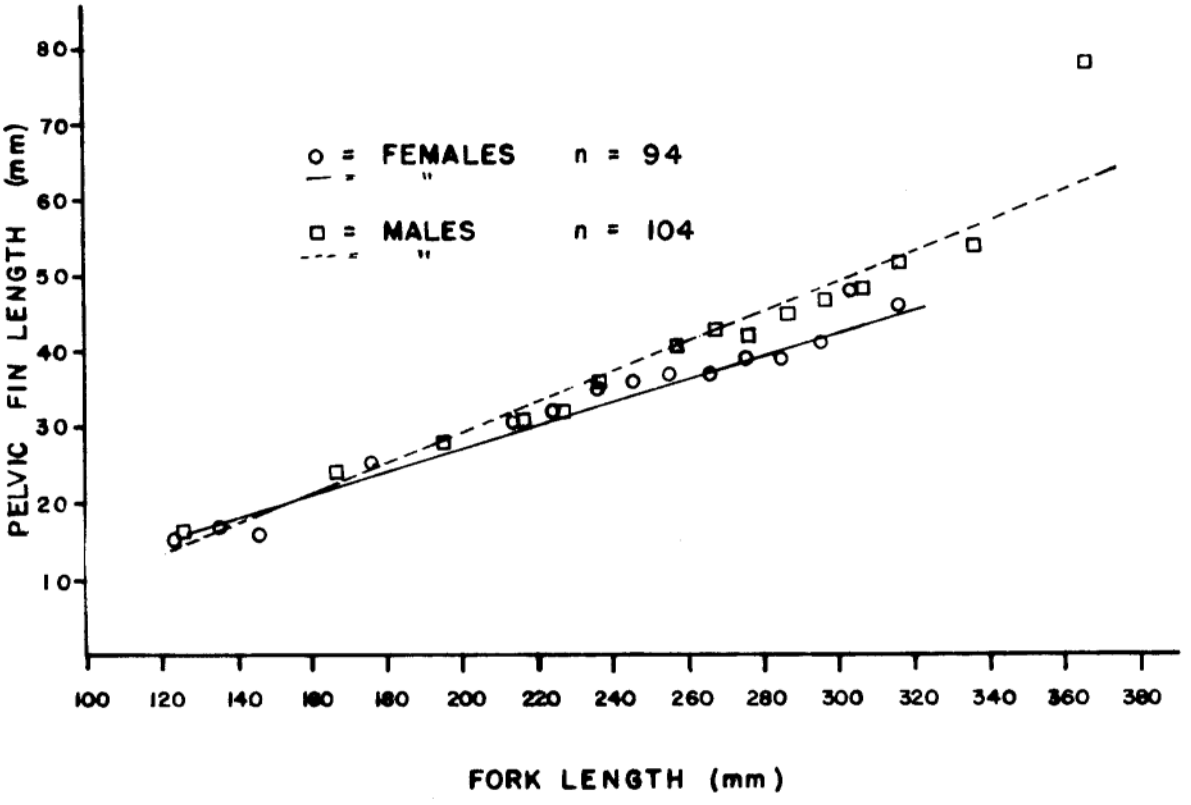

FIGURE 3 Linear Regression of Pelvic Fin Length on Fork Length for Grayling from the Upper Chena River. Each Point Represents the Mean Pelvic Fin Length for each 10 mm Length Group.

To test grayling swimming ability, an apparatus was used which consisted of a 4' X 4' X 4' hydraulic head box from the bottom of which water flowed into a trough 8 feet long, 1 foot wide and 1 foot high. The trough was attached to the head box with heavy rubber so the angle of the trough could be changed allowing for regulation of water velocity. A sliding door on the head box regulated the amount of water entering the trough. One 2.5 inch and one 3.0 inch electric pump was used to pump water from the river into the head box. One half inch hardware cloth barriers were placed across the trough, 1.5 and 3.5 feet, from the head box to form a swimming chamber.

A Gurley No. 625 Pygmy current meter was used to monitor water velocities in the swimming chamber. The water temperature during testing remained at 11°C. Water depth in the test chamber ranged from 2 to 3 inches. Grayling were captured by electrofishing and seining, then held 24 hours before testing. Fish were put in the swimming chamber three or five at a time. Timing commenced when the fish began swimming against the current and ended when the fish fell against the downstream screen. The maximum duration of a run was 20 minutes.

One problem encountered with the apparatus was the tendency of grayling to swim downstream when frightened. It was often impossible to get the fish to leave the downstream screen and swim into the current even by temporarily reducing the water velocity to near zero. Darkening the upstream end of the chamber did not seem to help. Once a fish started swimming upstream it usually continued to do so until fatigued.

Results in Table 10 indicate that 120 - 150 mm grayling which would be predominantly in their second year of life can swim for brief periods of time in a water velocity of 3 fps. Grayling 150 - 200 mm, age II to III can swim briefly in water flowing 3.5 fps.

Job R-I-B Early Life History of the Arctic Grayling

Objectives:

1. To determine the substrate characteristics, temperature, flow topography, depth, and light conditions on the spawning grounds at Mineral Lake outlet in relation to incubation time and fry emergence.
2. Determine aspects of spawning behavior important to spawning success.
3. Determine sex ratio, age composition, age at maturity, fecundity, testes development, and gamete development.
4. To determine those fish that prey on grayling eggs.
5. To find spawning sites in Chena River.

Mineral Lake Outlet - Post Spawning Movement

Persistent high, turbid water prior to and during spawning at Mineral Lake Outlet in 1972 resulted in the inability to maintain a temporary weir in this location. Consequently, movements following spawning were

TABLE 9 The Coefficient of Condition of Arctic Grayling Captured in the Upper Chena River During April, May and June, 1972.

Fork Length in mm	Coefficient of Condition			
	Females		Males	
	n	$\bar{x}$	n	$\bar{x}$
101 - 150	11	0.99	6	1.0
151 - 200	5	1.0	11	1.5
201 - 250	26	1.1	17	1.0
251 - 300	44	1.0	46	1.0
301 - 350	8	.99	21	.98
351 - 400	—	—	3	1.0
Total	94	1.0	104	1.1

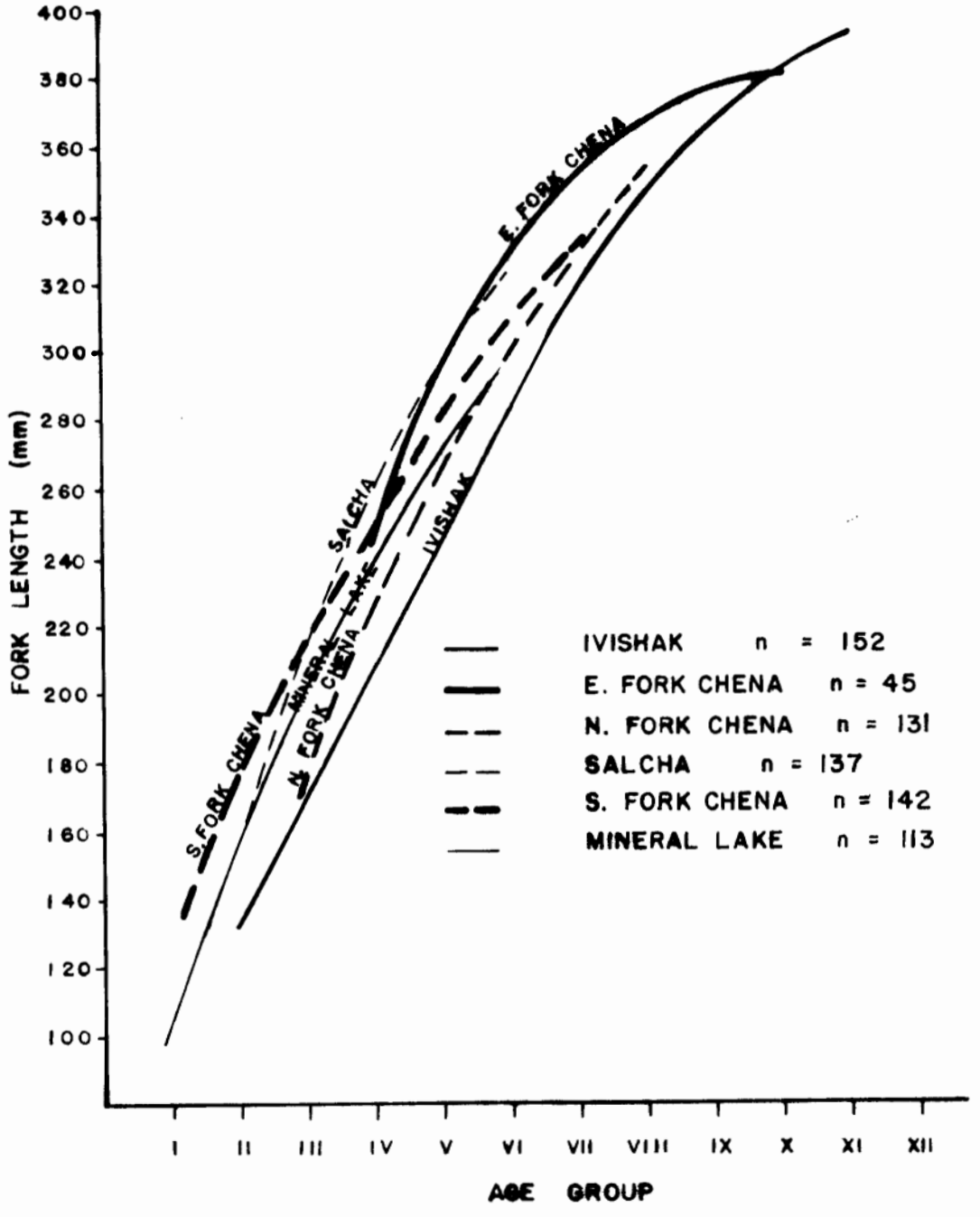

FIGURE 4 Growth Curves for Grayling from Six Interior and Arctic Waters, 1971 and 1972.

studied by netting at various sites throughout the system rather than by tagging. This method was feasible because netting in the spring of 1971 showed that, as of spawning time, no grayling were present any further up in the Little Tok or Mentasta Creek drainages than at the spawning grounds in the outlet of Mineral Lake (Tack, 1972).

Though direct observation was not possible, spawning probably began May 24 when the water temperature first reached 3.9°C.

On May 29, a gillnet set in Mineral Lake about 100 m (330 ft.) above the outlet source captured nothing in an overnight set, but when next checked on May 31, it contained 27 grayling. The catch included many immature grayling, some spent males and females and five partially spent females. This may indicate that some spawning occurs in the lake, but more likely these females entered the lake to feed or to avoid large ice flows moving down the outlet at this time.

A net in the Little Tok River 200 m (660 ft.) below the Mineral Lake Outlet caught nothing (overnight May 29).

From June 8 through 15, only one grayling was captured in the lower 100 m of Mineral Lake Outlet. Grayling were, however, captured in the Little Tok River above its confluence with the Mineral Lake Outlet and also in this river about 13 km (8 mi.) below the confluence between June 8 and 15. All of the grayling captured in the Little Tok above Mineral Lake Outlet were spent and are presumed to have come from the outlet area, as no spawning grayling were noted in 1971 netting of the Little Tok River. The extent of movement both up and down the Little Tok appears small at this time.

Most of the grayling leaving the spawning grounds seemed to move up into Mineral Lake and into Mentasta Creek, the primary inlet to Mineral Lake. Two net sites in Mentasta Creek, 1.6 km (1 mi.) and 16 km (10 mi.) from the lake produced consistent catches from June 8 to 15. Anglers made good catches of grayling in Mineral Lake during this week.

Mineral Lake Outlet - Bottom Samples:

Samples of the stream bottom in Mineral Lake Outlet were taken from seven places in the upper 100 m of the outlet. The samples were taken by scooping into the bottom with a one gallon plastic jar at a site where a pair of grayling were observed spawning. The results presented in Table 11 show a relatively uniform distribution of particle sizes from .075 mm (.0029 in.) to 38.1 mm (1.5 in.) with the exception of particles less than .075 mm which make up a very small part of the samples. This analysis does not necessarily represent spawning substrate requirements but is the first step in the long process of finding these requirements.

TABLE 10 Sustained Swimming Time of Two Length Groups of Grayling at Various Water Velocities as Measured by Repeated 20 Minute Test Runs.

Water Velocity Feet per Second	120 - 150 mm				150 - 200 mm			
	Number of Fish Entered	Number of Fish That Swam	Minutes Swam		Number of Fish Entered	Number of Fish That Swam	Minutes Swam	
			Mean	Range			Mean	Range
1.0	5	3	20.0	20.0-20.0				
1.5	5	5	6.0	2.0-12.5	5	5	15.4	8.2-20.0
1.5					5	5	9.6	4.4-13.5
2.0	5	1	20.0		5	1	20.0	
2.0	5	2	17.2	14.4-20.0				
2.5	5	3	13.6	1.0-20.0	5	4	2.0	0.8- 3.8
2.5	5	4	0.7	0.2- 0.8	3	2	20.0	20.0-20.0
2.5					2	2	13.5	7.0-20.0
2.5					3	3	8.2	7.0- 9.5
2.5					3	2	20.0	20.0-20.0
2.5					2	2	16.0	16.0-16.0
3.0	5	0			5	3	2.8	1.0- 3.7
3.0	5	1	0.8		3	3	8.3	2.0-20.0
3.0	3	2	2.0	1.0- 3.0	3	2	3.2	0.5- 6.0

TABLE 10 (Cont.) Sustained Swimming Time of Two Length Groups of Grayling at Various Water Velocities as Measured by Repeated 20 Minute Test Runs.

Water Velocity Feet per Second	120 - 150 mm				150 - 200 mm			
	Number of Fish Entered	Number of Fish That Swam	Minutes Swam		Number of Fish Entered	Number of Fish That Swam	Minutes Swam	
			Mean	Range			Mean	Range
3.0	3	0			3	0		
3.0	3	2	3.0	2.5- 3.5				
3.5					3	2	1.9	1.8- 2.0
3.5					3	1	8.7	

Job R-I-C Winter Ecology of the Arctic Grayling

Objectives:

1. To develop methods of sampling grayling during the winter months.
2. To find limits of distribution and important areas of concentration in the Chena River.

As of report writing time, no winter work has been undertaken on the Chena River, however, arrangements have been made to obtain an underwater television camera for testing in the Chena and other nearby rivers.

Winter conditions in the lower Goodpaster River were studied during early March. Holes through the ice at known riffle areas in the lower 2.5 km (1.6 mi.) of the river revealed flowing water at each site. At one riffle only 15 cm of unfrozen water remained below the ice.

At the confluence of the north mouth of the Goodpaster River and the Tanana River no unfrozen water was found. There was a visible drop in the surface of ice from the Goodpaster to the Tanana River. Since water was flowing in the north mouth of the Goodpaster River (further upstream), the flow was assumed to pass through the bottom gravel or some small undiscovered channel or ice fissure. The south mouth of the Goodpaster did not appear to be receiving water at its source.

The dissolved oxygen content of the water in the lower Goodpaster River was 4 and 5 ppm at two stations. The CO_2 content was 45 ppm, the pH was 6.5, and the Methyl Orange Alkalinity was 70 ppm. The ice thickness was about 80 cm and the snow was a fairly uniform 40 cm in the area.

Fifteen hours of tip-up fishing took nothing, but conditions appear favorable for fish to overwinter in the lower Goodpaster River.

Job R-I-D Creel Census of the Sport Fishery in the Tanana River Drainage

Objectives:

1. To obtain estimates of fishing pressure and catch in grayling waters to evaluate the fishery from year to year.
2. To determine the age makeup of the catch.

Badger Slough

The fishery on Badger Slough was censused from April 8 through May 24, 1972, which included the major portion of the fishery. Total angler hours as estimated from randomized counts and catch statistics obtained from angler interviews are summarized in Table 12.

In comparison to past years (Roguski and Winslow, 1969; Roguski and Tack, 1970; Tack, 1971), the angler hours for May, 1972 (5,833) remained about the same as 1968 (5,828), 1969 (5,374) and 1970 (6,206). The

TABLE 11 Particle Size Makeup of Seven Bottom Samples Taken from the Grayling Spawning Grounds in the Outlet of Mineral Lake, 1972.

	Percent Dry Weight by Material Size						
Total Sample Dry Weight	Less Than .075 mm (.0029 in)	.075-2.36 mm (.0029-.0933 in)	2.36-6.35 mm (.0937-.25 in)	6.35-12.7 mm (.25-.5 in)	12.7-25.4 mm (.5-1.0 in)	25.4-38.1 mm (1.0-1.5 in)	Greater than 38.1 mm (1.5
1145.9	1.3	29.8	29.8	20.2	11.3	7.5	0.1
1201.0	0.7	14.0	25.7	33.2	21.8	4.6	0.0
693.0	0.9	7.1	13.7	19.5	24.1	17.5	17.3
1365.0	1.2	6.9	8.9	16.1	25.8	12.6	28.6
1993.0	0.6	9.5	14.4	15.2	13.1	16.2	31.1
2021.0	0.7	14.6	14.8	18.6	26.2	25.1	0.0
2240.0	0.3	17.7	15.8	21.2	23.4	11.1	10.4
Mean $\bar{x}$ 1237.0	0.8	14.2	17.6	20.6	20.8	13.5	12.5

TABLE 12 Creel Census Results from Badger Slough, April 8 - May 24, 1972.

	Angler Hours				
	Weekdays		Weekends & Holidays		
Dates	6 AM-2 PM	2 PM-10 PM	6 AM-2 PM	2 PM-10 PM	Total
4/8-26	217	520	274	330	1,341
4/27-5/24	716	2,565	1,141	1,411	5,833
				Total Angler Hrs.	7,174

Number of Anglers Interviewed - 141
Mean Duration of Angler Trip - 2.0 hrs.
Total Anglers Trips - 3,587
Total Grayling Taken - 6,170
Number of Grayling per Angler Hour - 0.86
Mean Length of Grayling Caught - 232 mm

Local Resident - 60% Military - 37.5% Tourist - 2.5%

Adult - 83% Youth - 17%
Male - 92% Female - 8%

TABLE 13 Creel Census Results from the Lower Chena River, May 25 - August 27, 1972.

Dates	Angler Hours		
	Weekdays	Weekends	Total
5/25-6/21	4,654	2,224	6,878
6/22-7/26	2,162	1,356	3,518
7/29-9/27	1,700	1,020	2,720
		Total Angler Hrs.	13,116

Number of Anglers Interviewed - 63
Mean Duration of Angler Trip - 1.7 hr.
Total Anglers Trips - 7,715
Total Grayling Taken - 10,099
Number of Grayling per Angler Hour - 0.77

Local Resident - 31% Military - 65% Tourist - 4%

Adult - 53% Youth - 47%
Male - 95% Female - 5%

catch per angler hour (0.86) is up from the low 0.43 in 1970 but about the same as the 0.82 and 0.80 in 1968 and 1969, respectively. As in the past, the duration of angler trips remained short (2.0 hours).

The average length of grayling taken was 232 mm (range 150-305 mm). Though fish were not systematically autopsied, several gravid females were noted. Seventeen percent of the 105 fish sampled were over the 270 mm fork length, above which all grayling are mature (Tack, 1971), thus indicating the presence of a large number of grayling that probably spawn in Badger Slough. That these fish spawn in Badger Slough is further supported by the known presence of young-of-the-year grayling several kilometers up the slough.

Lower Chena River

On May 25, 1972, creel census effort was shifted from Badger Slough to the 34 km of Chena River between the mouth of Badger Slough and its confluence with the Tanana River. The census ran until September 27. Results are presented in Table 13.

An estimate of 13,116 angler hours was obtained, ranking this fishery at about the same importance as the upper Chena River (Tack, 1971). Unlike the upper Chena River but more like the Badger Slough fishery, effort is spread more evenly between weekdays and weekends; also the duration of angler trips is short (1.7 hours). The fishery is dominated by military personnel and dependents (65%) and youth (47%).

Job R-I-E Experimental Stocking of Arctic Grayling

Objectives:

1. To determine the growth and survival of grayling in various lake types.
2. To investigate interspecific and intraspecific competition in the Arctic grayling.

Table 14 gives the results of dissolved oxygen testing, test netting and electrofishing in five lakes previously stocked with grayling fry. Since no fry were available for stocking in 1971, survival would have been from the stock of 1970 or earlier.

Big Lake carried grayling through the winter of 1970-71 but no grayling were found by electrofishing after the winter of 1971-72. However, no dead fish were seen while shocking so there may have been some survival. The lake was restocked with 50,000 fry in 1972.

Engineer Hill Lake showed no grayling survival in 1972 even though the dissolved oxygen level remained high. Apparently, the low oxygen level during the winter of 1970-71 severely reduced the grayling population. This was evidenced by the capture of only one grayling in netting during the summer of 1971. This lake was restocked with 50,000 grayling fry in 1972.

TABLE 14 Dissolved Oxygen and Fish Survival in Lakes Experimentally Stocked with Arctic Grayling.

Lake	Lowest Measured D.O. (ppm)	Date	Fish Captured	Date Captured	Range (mm)	Mean	Age	Year Stocked
Big Lake	0.6	4/6/72	None*					1967,1970,1972
Engineer Hill Lake	6.5	3/15/72	950 chubs 5 SF	8/11/72				1968,1970,1972
FAA Pond	13.0	3/18/72	12 S 1 NP	7/28/72				1970
Left O.P. Lake	0.6	4/6/72	Winter killed in 1971					1967,1970
Otto's Lake	0.0	3/18/72	3 GR 1 NP	7/28/72	285-300	290	II	1967,1968,1969, 1970,1972

*Sampled by electrofishing only.

No survival of grayling was found in F.A.A. Pond in 1971. This was confirmed in 1972. The reason for the failure of grayling to establish in this pond probably rests with predation from Northern pike. The banks of this pond are steep providing virtually no cover for rearing fish. This pond would have to be rehabilitated before grayling could be established.

Left O. P. Lake winterkilled in 1970-71. The water level has been down three to four feet in this lake since 1970 and it has been anoxic each winter since 1970. This lake will not be suitable for stocking until the water level rises.

Though no dissolved oxygen could be found in Otto's Lake in March of 1972, some survival occurred. Apparently, there is a source of oxygenated water somewhere in the lake. The grayling that survived exhibited rapid growth reaching 290 mm fork length in 2.5 years. This lake was restocked with 75,000 fry in 1972.

LITERATURE CITED

Kruze, T. E. 1958. The Grayling of Grebe Lakes, Yellowstone National Park, Wyoming. Dissertation Abstracts 9 (3): 605 pp.

Roguski, E. A. and P. C. Winslow. 1969. Investigations of the Tanana River and Tangle Lakes Grayling Fisheries: Migratory and Population Study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1968-1969, Project F-9-1, 10: 333-351.

Roguski, E. A. and S. L. Tack. 1970. Investigations of the Tanana River and Tangle Lakes Grayling Fisheries: Migratory and Population Study. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1969-1970, Project F-9-2, 11: 303-319.

Tack, S. L. 1971. Distribution, Abundance and Natural History of the Arctic Grayling in the Tanana River Drainage. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1970-1971, Project F-9-3, 12: 35 pp.

Tack, S. L. 1972. Distribution, Abundance and Natural History of the Arctic Grayling in the Tanana River Drainage. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1971-1972, Project F-9-4, Volume 13.

Van Hulle, F. D. 1968. Investigation of the Fish Populations in the Chena River. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Progress, 1967-1968, Project F-5-R-9, 9: 287-304.

Prepared By:

Stephen L. Tack
Fishery Biologist

Approved By:

s/Howard E. Metsker
Chief, Sport Fish Research

s/Rupert E. Andrews
Director of Sport Fish